A

SCHEME

FOR

EFFECTUALLY SUPPLYING

Every PART of the

CITY of *DUBLIN*

WITH

PIPE-WATER,

Without any Charge of *Water-Engines*, or any *Water-Forcers*, by a close Adherence only to the *natural Laws* of GRAVITATION, and the *Principles*, *Rules*, and *Experiments* of

HYDROSTATICKS.

DUBLIN:

Printed by SYL. PEPYAT, Printer to the Honourable City of *Dublin*, MDCCXXXV.

A

SCHEME

FOR

PERPETUALLY SUPPLYING

Every Part of the

CITY of DUBLIN

WITH

PIPE-WATER.

Without any Charge of Water Rents,
or any Tax or Burden upon the Citizens,
only to the reasonable Profits of the Undertakers
and the Proprietors of the Canal.

A SCHEME *for* effectually ſupplying *every Part of the* City *of* DUBLIN *with* Pipe-Water, *without any Charge of* Water-Engines, *&c.*

I. HERE is an Eſtimate made, to ſhew the Expence of this *Scheme*; and if it ſhould appear, that it will not be an Expence at all, it will probably be the only *Scheme*, that will appear without any.

It is intended by this *Scheme*, that there ſhould be three diſtinct *Mains*, and each of the three *Mains* to have a ſix Inch Bore, or

as much more as can be, and to begin at *James*'s Gate, and proceed in the following Order.

		l.	*s.*	*d.*
1st Main.	FROM *James*'s Gate, to *Catherine*'s Church, thence down to *Ellis*'s Bridge up *Queen-ſtreet* to the Head thereof, thence along *King-ſtreet*, *Little Green*, ſo to the Head of *Capel-ſtreet*, is by Mr. *Brooking*'s Map 7224 Feet, which at 12 *d. per* Foot, is	361	04	0
2d Main.	FROM *James*'s *Gate*, along *Thomas-ſtreet*, *Corn-market*, *High-ſtreet*, *Skinner-Row*, down *Warbrough*'s-*ſtreet*, *Bride-ſtreet*, up *Peter-ſtreet*, and ſo to *Stephen*'s *Green*, 8610 Feet, at 12 *d. per* Foot, is	430	10	0

FROM

From *James*'s *Gate* along *Thomas-ſtreet*, *Corn-market*, *High-ſtreet*, *Skinner-Row*, *Caſtle-ſtreet*, *Cork-Hill*, *Dame*'s-*ſtreet*, *College-Green*, along *Lazer*'s *Hill*, as far as Lord *Mazareen*'s Houſe, 9660 Feet, at 12 *d. per* Foot.	3d Main.	
	l.	*s. d.*
	483	00 0
The total Expence of the Pipes, - - -	1274	14 0
There will be expended upon ſome neceſſary Improvements of the Aqueduct, from the Bason to *James*'s *Gate*, by Eſtimation about - - -	50	00 0
And alſo ſome eſſential Improvements, in the ſeveral Courſes of the *Main Pipes*, by Eſtimation about	50	00 0
	1374	14 0

It

It is propoſed that this Work ſhall be performed by your own Workmen, (under my Direction) and no Money is required to paſs thro' my Hands, but the Expence to be defrayed by your own Treaſurer.

All other *Mains* of leſſer Bore, which branch off to either hand, I call *inferior Mains*, but a very ſmall Expence can ariſe by joining them to the *new Mains*, as we paſs along, nor will any of thoſe branching *inferior Mains* be removed or altered, except ſuch as are defective; and whatever Expence ariſes that way, cannot be ſaid to enhance the Charge of this SCHEME; that being a Work of Neceſſity, and to be done, if this or any other SCHEME had never been thought of.

Nor can the branching off of *new inferior Mains*, where none have been before, be ſaid to add to the Expence of this SCHEME; ſo that it

is obvious that this SCHEME is not attended with *Expence*, according to the true Meaning of the Word; ſince he can never be charged with Expence, who lays out Money to Advantage, and purchaſes at a very low Value.

This we take for granted, that there are *inferior Mains* to be taken up, where the *new Mains* will be laid down; and they will ſerve for *inferior Mains* in other Places.

When it is proved that we have Sufficiency of Water, then the Frugality of the Purchaſe will be fairly proved; conſequently the foregoing SCHEME is not a SCHEME *of any Expence.*

One thing ſeems much to be doubted, Whether there be already a Quantity of Water ſufficient for this Purpoſe? To this I anſwer, *That there is.*

As it is intended by this SCHEME, that there ſhould be *three Main Pipes*, the Bore of each to be ſix Inches

Inches Diameter; (or as much more as can be) the Area then of that Circle, whoſe Diameter is Six Inches, is 28 Inches, and near a Quarter, and no more can poſſibly enter the Mouth of one of theſe Pipes, at any one Time; becauſe Water cannot be compreſſed as Air may; therefore the *three Mains* will take, in the Sum of all their Entrances, 85 ſquare Inches nearly; and 85 cubic Inches is ſomething more than three Pints: and the Water received into theſe *three Pipes*, and rightly diſtributed by the Help of Stop-Cocks, will ſupply all this City.

Now ſurely it muſt be allowed, that we can conſtantly command a Stem of Water, above ten Times the Size of this, in the very drieſt Summer, and we have already the Conveniency of a RESERVOIR, or BASON; which is of very great Uſe; and might have been of greater, had it not been for the unskilful

Method

Method of conveying the Water from thence; in which has been ſhown as groſs Ignorance in *Hydroſtatics*, as in a late Propoſal of a *Water-Engine*.

There is a natural Advantage in the Situation of the BASON in the moſt eminent and remote Part of the City; ſo that little remains to be done but to help and improve Nature in the very Way that ſhe herſelf acts.

The great Sir *Iſaac Newton* has demonſtrated, that the Preſſure of Fluids is equal every Way; the Bottoms and Sides of Veſſels are preſſed as much as the neighbouring parts of the Fluid: This Action then increaſes in Proportion to the Height of the Fluid, and does not at all depend on the Quantity contained in the Veſſel, (as our BASON;) therefore, when the Height of the Liquid, and Bigneſs of the Bottom remain the ſame, the *Action* upon the Bottom is always equal.

Hence the Preſſure ſuſtained by the Bottom, is equal to the Weight of a Column of Water, of the Form and Size of the Base, and of the Height or vertical Diſtance from the Surface.

Many and extenſive in their Uſes are the Principles in *Hydroſtatics*. This one only is neceſſary for our preſent Purpoſe, which, when well underſtood, digeſted and extended, is ſufficient to effect the Work intended by this Scheme. And deducible from it, are theſe two following *Theorems*.

Fig. 1.

Firſt, If a *Recurve*, or *bended Tube*, as A. B. be open at both ends, Water in ſuch a *Tube*, as at A. and B. will ever keep parallel to the Horizon, and all the intermediate Parts between the two Surfaces, on Account of the Cohe-

Coheſion of the Particles of Water, will be ever united, and ever full.

2*dly*, If a *Recurve*, or *bended Tube*, as C. D. be ſtopped at the upper End D, the Water put into ſuch a *Tube* at C, after it is ſufficiently ſtopped at upper D, will never riſe in the End D, to the Height of the Surface at C; becauſe the Elaſtic Force of the compreſt Air, muſt unavoidably burſt the Pipe, whenever it exceeds the Power of its Confines. Hence may be conceived the Reaſon of the frequent Burſting of Pipes.

Fig. 2.

From the foregoing Principles it is, that I ſhall be able without Difficulty to ſend Water in *Pipes* to every Part of this City: and I alſo can, upon the ſame Principles, virtually, (tho' not actually) remove and have all the Advantages of

the Water in the Bason, in any Part of the City; without occupying more than one Foot of Ground in any one Place.

If it be ſaid, That in the Method agreeable to the foregoing Principles, the Water in *Pipes* going down from *Catharine*'s Church to *Ellis*'s Bridge, or any other great Deſcent, will not, cannot add to the Velocity of the Water's Current, thus going down a Deſcent, it might ſeem extraordinary; but is demonſtrably true, ſince *Action* and *Re-action* are equal, and by the Laws of *Gravitation* all the Waters contained in the *Pipes* will be in *Equilibrio.*

This may alſo appear to be another Paradox, that the farther from the Bason a *Pipe* or *Branch* is opened, the greater will the Velocity of the *Iſſuing Water* be; whereas we have known that in former Practices the direct contrary has appeared: the Undertakers not

not knowing the Cauſe; not knowing that Air compreſt or pent up, and Friction, occaſions a Reſiſtance, retarding the Velocity which the Water had in its naſcent State; and 'tis to be obſerved, the greater and ſmoother the Bore, the ſmaller will be the Reſiſtance from theſe combining Cauſes.

This is not a chimerical SCHEME, having fraudulent BASES, but is founded upon obvious, rational, accurate and demonſtrative Principles, ſcientifical.

All which is moſt humbly ſubmitted to the Conſideration of the Right Honourable the Lord Mayor, Aldermen, Sheriffs, *and* Commons *of the Honourable City of* DUBLIN, *by*

GAB. STOKES.

Some OBSERVATIONS *and* CALCULATIONS *on the* PIPES.

Diameter of the Bore. } 6 Inches. { The Areas of such Diameters. } *Sqr. Inches.* 28.274328 { The Sum of such Areas. } 3 *Sqr. Inches.* 84.822984

The Length of the		*Inches.*	The Content of each *Main* in Gallons.	*Gallons.*		In Barrels.	*Barrels.*
	1st Main	86688		11264			268
	2d Main	103320		13425			319
	3d Main	115920		14979			356
				39668			943
The Content of all the *inferior Mains*,				119004			
				158672	$\frac{1}{3}$	=	52890 = 5,

FROM

FROM the *Hearth-money* Books for the Year 1734 it appears, that all the Houſes and Cabbins (for Cabbins are not diſtinguiſhed from Houſes in the *Hearth-money* Books, but by having a ſingle Fire-place) in the City, Suburbs, and ſeveral Liberties, in and about DUBLIN, amount to 11402 Houſes and Cabbins; from which if the Houſes and Cabbins in the Earl of *Meath*'s, the Archbiſhop of *Dublin*'s, and *Chriſt-Church* Liberties, and all other ſmall Houſes and back-Houſes within the City are deducted, there will remain 4200 Houſes, which ought to pay *Water-money*.

The Branches that ſupply *Pipe-water* for private Uſe, are generally Leaden-branches of an Inch-bore, having Braſs-cocks; which Braſs-cocks reduce the Inch-bore to five tenths of an Inch. By repeated Experiments I have found, that there

there iſſues from ſuch a Cock, 25 Pints in one Minute of Time; conſequently from one of the *Mains* of ſix Inches Diameter (having a proportionable compreſſing Force,) there will flow 3600 Pints in the ſame time.

Subſtitute D and d for the greater and leſſer Diameters, F and f for the greater and leſſer Quantities flowed in equal Times. Then by 2. 12 *Eucl.* $\frac{f D^2}{d^2} = F = 3600$ Pints. *Theor.* 1.

Our Experiment was moſt accurately tried in the following Manner. An exact vertical Line was erected for the Purpoſe, on which was ſuſpended a Plummet and String, whoſe Diſtance from the Center of *Suſpenſion* to the Center of *Oſcillation* was $39.2^{\text{Inches,}}$ which is the exact Length that vibrates *Seconds*.

When this Plummet had vibrated 30 times, the Cock was ſtopped, and the Quantity of Water which had iſſued forth meaſured, by ſe-

veral Trials it was found to be 12·5 Pints, conſequently there will iſſue 25 Pints in one Minute of Time.

Theor. 2. Put $h = \frac{1}{3}$ of the Number of Houſes, then $hf = 35000$ Pints, which is the Quantity that $\frac{1}{3}$ of the *Pipes* would diſcharge in the ſame given time.

If all the Houſes were to draw Water the whole 24 Hours, each Houſe would have 12 Barrels of Water nearly to its Share. Put g. for the Number of Gallons in 3600 Pints, M. for the Minutes in 24 Hours, and m. for the Minutes in

Theor. 3. 14 Hours, then $\frac{Mg+s}{h} = 500$ Gallons $= 12$ Barrels nearly. But ſuppoſe one Day with another they were to draw Water 14 Hours, then

Theor. 4. $\frac{mg+s}{h} = 307$ Gallons $= 7$ Barrels nearly to each Houſe, which is abundantly more than ſufficient for any Houſe, except publick Brewers.

Now half a Barrel of Water, which is 168 Pints, being divided by

by 25 (the Number of Pints which iſſues in one Minute,) the Quotient will be 6 Minutes, 43 Seconds; ſo that in every $6\ 43$ every Houſe will receive half a Barrel of Water nearly; ſo conſequently in every $13\ 26$ every Houſe will receive one Barrel nearly, which is more than one Houſe in twenty uſes, or can uſe.

Wherefore upon this *Hypotheſis*, admit every tenth Houſe to ſuffer their Pipes to run perpetually, there would be a Redundancy of Water. For the Quantity which each *Pipe* is capable of receiving in one Minute, is greater by 100 Pints than the Quantity flowing from $\frac{1}{3}$ of the Branches in the ſame time. Put e for 10, then $\frac{hf}{e} = F - e^2 = 3500$ *Theor.* 5. Pints for the Quantity flowing out in one Minute, which is leſs by 100 Pints than 3600 Pints, which is the Quantity flowing in, in one Minute.

And

And it would be $13'\ 28''$ before the *Pipes* could be exhauſted, when all are flowing in and out, (except the flowing Part) Put r for the Number of Pints contained in one Gal-

Theor. 6. lon; then $\frac{sr}{hf-F} = 13'\ 28''$.

And all the *Pipes* will receive a full Charge in every $^{h}1\ 57'\ 32''$, when the diſcharging Cocks are ſtopped;

Theor. 7. for $\frac{s}{g} = {}^{h}1\ 57'\ 32''$, by which divide the 24 Hours, and the Quotient will ſhew, that the *Pipes* could be filled ſomething more than 12 times in the 24 Hours.

On the AQUEDUCT *and* BASON.

HAVING already ſaid what ſeems moſt neceſſary concerning the Laws of Nature, ſo far as they relate to my preſent Purpoſe; I come now to demonſtrate the Sufficiency of Water for eight *Mains* (inſtead of three) even in the drieſt Summer, (but then the Water in the AQUEDUCT and BASON muſt be preſerved from Waſte.)

According to *Brooking*'s Map of the BASON, when there is 120 Inches, or 10 Foot Depth of Water, it muſt contain 32300880 Gallons; for which we ſubſtitute s.

The AQUEDUCT, which conveys the Water to the BASON, is full five Foot broad, having an uniform right lined BASE. The Angle of its Declivity, which it makes with the Horizon, may be known by finding the

the Velocity of the Water in any given time, for the Velocity of the Water, and Declivity of the Bases, are reciprocally proportional.

It is allowed, that in the drieſt Summer, (when the Mills have confined the Water) there is a Stream of 9 Inches deep, and better than 12 Inches when it is not confined; and this pounding is but once a Day (ſeldom twice) for three Hours (ſeldom four) and all ſuch pounding Days added together, cannot exceed 26 or 28 Days in a whole Year. The following Computation, in order to be free from Objection, admits 8 Hours pounding at 9 Inches deep, and the remaining 16 Hours at 12 Inches deep. It is alſo admitted by our modern Virtuoſo's, that the Bottom and Top of running Waters in open Rivers and Aqueducts have different Velocities, as the Baſes and

Depths

Depths are differently circumſtanced.

I have had the Curioſity, more than once, in very dry Summers, to meaſure the different Velocities at Top and very near the Bottom of our preſent AQUEDUCT; and ſettled a mean Velocity of 40 Foot in one Minute of Time; and alſo obſerved it the third of *March* after it had rained two Days, which ſwelled the Water in the AQUEDUCT to 30 Inches deep, and cauſed the Velocity to increaſe 58 Inches in the ſame given time: However, we ſhall uſe in this Computation the leſſer Velocity, as well as the leſſer Depth, to avoid all Objections.

Being thus prepared for Computation, I ſhall give moſt accurate Anſwers to the ſix following neceſſary Queſtions.

Is the Supply of WATER through the AQUEDUCT at 9 Inches Queſt. 1.

Inches deep for 8 Hours, and 12 Inches deep for the other 16 Hours for 28 Days, and 10 Foot Depth of Water in the BASON at the Beginning, ſufficient for feeding 8 *Mains*, each to have a ſix Inch Bore? The Queſtion is, What is the Supply of each Day having 24 Hours, and the Diſcharge of each Day having 14 Hours.

Subſtitute b, for the Breadth of the AQUEDUCT, d, for the leſſer Depth, D, for the greater Depth, v, for the Velocity, t, the leſſer Time, T, the greater Time, c, the cubical Inches contained in one Gallon, a, the Gallons drawn from the BASON in one Minute by 8 *Mains*.

Theor. 1. Then will $\frac{bvdt+bvDT}{c} = n = \overset{\text{Gallons}}{2096470}$, the Gallons flowing into the BASON in 24 Hours; and a m, $= N =$

Theor. 2. $\overset{\text{Gallons}}{3024000}$, the Gallons iſſuing from the BASON in 14 Hours, by which it appears that the Diſcharge is greater

er than the Charge; conſequently then, that the BASON could be exhauſted in $\overset{\text{Days}}{34}\ \overset{\text{h}}{19}$, but not in 28 Days, as appears by $\frac{s}{N-n} = \overset{\text{Days}}{34}\ \overset{\text{h}}{19}$. Put *Theor.* 3. i, for 28 Days:

Then $ni + s - Ni = k = 6330040$ *Theor.* 4. Gallons, which will be in the BASON at the End of 28 Days: put l, for the Number of Gallons in the BASON at one Inch deep from the Surface; then $\frac{k}{l} = \overset{\text{Inches}}{23.5}$ for the Depth of *Theor.* 5. Water in the BASON at the End of 28 Days.

The BASON being already 10 Foot deep; What Depth of Water in the AQUEDUCT will be ſufficient to keep it always ſupplied to that Height, when conſequently the flowings in and out would be equal? *Anſ.* $\frac{Nc}{bvM} = \overset{\text{Inches}}{15.8}$. *Theor.* 6. Hence $\overset{\text{Inches}}{15.8}$ is a ſufficient Depth, and is but half the Depth which I found in the AQUEDUCT the 3*d* of *March*. Q. 2.

If the BASON were filled to the Height of 10 Foot, and no freſh Supply of Water admitted; How Q. 3.

long would ſuch a Quantity in the BASON ſupply this City in the Terms

Theor. 7. of 8 *Mains*. *Anſ.* $\frac{s}{N} =$ Days 10 h 16.

Q. 4. How many Days wou'd the BASON be in filling to the Height of 10 foot, under the forementiond Diſadvantages of the drieſt Summer, ſuppoſing

Theor. 8. no Diſcharge? *Anſ.* $\frac{s}{n} =$ Days 15 h 9.

Q. 5. If the BASON were empty, in how many Days would it be filled to the height of 10 foot, ſuppoſing no Diſcharge, and the Quantity flowing in equal to what would be diſcharg'd, were the Pipes open'd? Put d, for the Depth of the AQUEDUCT, as it was found by *Queſt.* 2. and *Theor.* 6. Then

Theor. 9. $\frac{sc}{bvdM} =$ Days 10 h 17.

Q. 6. How many Days would the BASON be in filling, having 30 Inches Depth in the AQUEDUCT, and the Velocity 44 Foot 10 Inches in one Minute of Time, as it had the third of

Theor. 10. *March?* *Anſ.* $\frac{sc}{bvdM} =$ Days 5 h 0 m. 58.

Delivered 25th *March*, 1735, } *by* GAB. STOKES.

THE MATHEMATICAL CABINET OF THE *Hydroſtatical Ballance*, unlock'd: OR, *An* EASY KEY *to all its* USES.

By *GA. STOKES* Mathematical Inſtrument-maker in *Eſſex-Street*, DUBLIN.

TO THE

RIGHT HONOURABLE

The LORD MAYOR,

Aldermen, Sheriffs *and* Commons *of the City of* DUBLIN.

THO' *the following* Problems *have no immediate Relation to the* SCHEME *to which they are annexed, yet being upon the Subject of* Hydroſtatics, *(a Subject which hath for ſome Years been the Entertainment of my leiſure Hours) I hope it may not be improper to preſent them to you here upon this Occaſion.*

My chief Motive for propoſing the foregoing SCHEME *is the Advantage of my Fellow-Citizens; and ſhould any other be offered more rational, I ſhall, as every good Citizen ought, yield it the Preference. But if my* SCHEME *upon Examination*

and

and Purſuance of the Theorems *thro' their Conſequences, be found as unexceptionable as any other, (as I think I may affirm it is,) and certainly much leſs expenſive than any yet offered; and even the Expence mentioned ſtill leſs conſiderable, as nothing is propoſed which would not be abſolutely neceſſary in any other Method of conveying Water thro'* Pipes: *I ſhall then preſume as a Citizen to hope for your Favour, in Preference to any Stranger; and am, with the greateſt Submiſſion,*

Your moſt humble, and

moſt obedient Servant,

GABRIEL STOKES.

The Deſcription *and* Uſe *of an* HYDROSTATICAL BALLANCE *in finding the Denſities or ſpecifick Gravities of Bodies or Fluids.*

THE ſeveral Parts which compoſe this Inſtrument in order to fit it for Uſe, are marked with the Letters *A. B. C. F. G.* and *H.* The Glaſs Bucket *H.* ſerves for holding ſmall Bodies of any Kind whatever, in Order to determine their Weights when immerged in Water or any other Fluid; and the Glaſs Bubble *G.* which has its Weights, in Air and common Pump-Water, ſcratched upon it, with the Difference between them, is uſed in comparing the Denſities of other Liquids with that of Water.

The Weight of *A.* in Air is equal to the Weight of *F.* and the Glaſs Bubble *G.* when the Bubble *G.* is immerged in Water; and *A.* is equal to *B.* and the Glaſs Bucket *H.* when weighed in Air; and *laſtly*, *A.* is equal to *B. C.* and the

Bucket

Bucket *H.* when the Bucket *H.* is immerged in Water.

PROB. I. *To find the ſpecifick Gravity of Bodies in general, that may without Injury be weighed in Water.*

The RULE.

Divide the Weight of any Body in Air, by the Difference between its Weights in Air and Water, the *Quotient* will be the ſpecifick Gravity of that Body.

EXAMPLE.

	Grains.
The Weight of a Body in Air, -	164
Its Weight in Water, - - -	155
The Difference, - - -	9

Divide 164, the Weight of the Body in Air, by 9, the Difference between its Weights in Air and Water, the *Quotient* $18\frac{2}{9}$, is the ſpecifick Gravity of that Body.

PROB. II. *To find the ſpecifick Gravity of Fluids in general.*

The RULE.

Divide the Difference between the Glaſs Bubbles Weight in Air, and its Weight in any

any Fluid, by the Difference between its Weight in Air and Water, the *Quotient* will be the ſpecific Gravity of that Fluid.

EXAMPLE.

	Grains.		*Grains.*
The Glaſs Bubbles Wt. in Air, - - -	1107	The Glaſs Bubbles Wt. in Air, - - -	1107
Its Wt. in Water, - -	603	Its Wt. in Spirit of Turpentine, - - -	666.5
The Difference, - - -	504	The Difference, - -	440.5

Divide 440.5, the Difference between the Glaſs Bubbles Weight in Air, and its Weight in Spirit of Turpentine; by 504 the Difference between its Weights in Air and Water, the *Quotient* .874 is the ſpecific Gravity of that Spirit.

PROB. III. *To find the ſpecific Gravity of Bodies that can't be weighed in Water without injuring the Bodies, but may be weighed in Spirit of Wine or other Fluids.*

RULE.

1*ſt*, Divide the Difference of the Body's Weight in Air, and its Weight in any Fluid, by the ſpecific Gravity of that

Fluid, the *Quotient* will be the Difference between that Body's Weight in Air and its Weight in Water, which Difference determines the ſpecific Gravity by *Prob.* 1. Or, 2*dly*, Divide the Product of the Body's Weight in Air, multiplied into the ſpecific Gravity of the Fluid, by the Difference between the Bodies Weight in Air and its Weight in that Fluid: the *Quotient* will be the ſpecific Gravity of that Body.

EXAMPLE.

	Grains.		*Grains.*
The Bodies W^t. in Air, —	240	The ſpecific Gravity of	
Its W^t. in Spirit of Turpentine,	117$\frac{2}{3}$	the Spirit of Turpentine given, — — —	.874
The Difference, — —	122$\frac{1}{3}$		

1*ſt*, Divide 122$\frac{1}{3}$, the Difference between the Bodies Weight in Air and its Weight in Spirit of Turpentine by .874 the ſpecifick Gravity of the Spirit, the *Quotient* 139.9694, is the Difference between the Body's Weight in Air and its Weight in Water, the ſpecific Gravity then reſolves by *Prob.* 1. 2*dly*, Divide 209.76 the Product of 240 the Body's Weight in Air, multiplied into .874, the given

given Specific Gravity of the Spirit by 122 $\frac{1}{3}$, the Difference between the Body's Weight in Air, and its Weight in Spirit of Turpentine, the *Quotient* 1.714 is the ſpecific Gravity of that Body.

PROB. IV. *To find the ſpecific Gravity of a Body lighter than Water, let it be ſunk by ſome heavy Body upon it.*——*Then*

The RULE *is,*

To divide the abſolute Weight of the lighter Body by the Difference between the abſolute Weight of the lighter Body added to the heavier Body's Weight in Water, and the joint Weight of theſe two Bodies in Water, the Quotient will be the ſpecific Gravity of the lighter Body.

EXAMPLE.

	Grains.	
The Wt. of the lighter Body in Air, -	193.5	Dividend.
The Wt. of the heavier Body in Water, -	218.1	
	412.3	
The joint Wt. of both Bodies in Water, -	168.3	
The Difference, - - - -	244	Diviſor.

Divide 193.5 the abſolute Weight of the lighter Body by 244, the Difference between the abſolute Weight of the lighter Body 193.5 added to 218.8 the heavier Body's Weight in Water, and 168.3 the joint Weight of thoſe two Bodies in Water; the *Quotient* .795 is the ſpecific Gravity of the lighter Body.

PROB. V. *To find the abſolute Weight of each Body when two Bodies are incorporated.*

Note. The ſpecific Gravity of the Matter of each Body muſt be given or found. The abſolute Weight and ſpecifick Gravity of the Mixture muſt be found alſo by *Prob.* 1.

The RULE.

Divide the Difference between the ſpecific Gravity of the Mixture, and the leſſer ſpecific Gravity of the Bodies, by a Product contained under the ſpecific Gravity of the Mixture, and the Difference of the given ſpecific Gravities; mul-

multiply the *Quotient* by the abſolute Weight of the Mixture into the greater ſpecific Gravity of the Bodies. The Product is the abſolute Weight of the Body that has the greater ſpecific Gravity; conſequently the Complement of it to the abſolute Weight of the Mixture, will be the abſolute Weight of the Body, that hath the leſſer ſpecific Gravity.

EXAMPLE.

The ſpecific Gravity of the Mixture,	13.11696	
The leſſer ſpecific Gravity of the Bodies,	8.34495	
The Difference,	4.77201	The Dividend.
The given ſpecific Gravities of the Bodies, Greater,	18.88888	
Leſſer,	8.34495	
Multiply the Difference,	10.54393	
By the ſpecific Gravity of the Mixture,	13.11696	
Their Product,	138.304	The Diviſor.
Multiply the abſolute Weight of the Bodies,	14.37293	
By the greater ſpecific Gravity of the Bodies,	18.88888	
Their Product,	271.48855	

Divide

Divide 4·77201, the Difference between the ſpecific Gravity of the Mixture and the leſſer ſpecific Gravity of the Bodies, by 138·304 the Product contained under the ſpecific Gravity of the Mixture, and the Difference between the given ſpecific Gravities; the *Quotient* ·0·345 multiply by 271·48855, a Product contained under the abſolute Weight of the Mixture 14.37293, and 18·88888 the greater ſpecific Gravity of the Bodies. This laſt Product 9.3663 is the abſolute Weight of the Body that hath the greater ſpecific Gravity: conſequently if taken from 14.37293 the abſolute Weight of the Mixture, there remains 5.00663 for the abſolute Weight of the Body, that hath the leſſer ſpecific Gravity.

PROB.

PROB. VI. *To find the abſolute Weight of any Body when its Magnitude is given in cubic Feet or Inches, together with the ſpecific Gravity of the ſaid Body.*

The RULE.

Divide the Product of 760 into the Magnitude and ſpecific Gravity by 3, the *Quotient* will be the abſolute Weight of the Body in Grains, when the Magnitude is given in cubic Inches.

Or 76, multiplied into the Magnitude and ſpecific Gravity, will give the abſolute Weight of the Body in Pounds *Troy*; when the Magnitude is given in cubic Feet.

PROB. VII. *To find the Magnitude of any Body when its abſolute Weight is given in Pounds* Troy *or Grains, together with the ſpecific Gravity of the ſaid Body.*

The RULE.

Divide 3 times its Weight by 760 times the ſpecific Gravity; the *Quotient* will be its Magnitude in cubic Inches, when the Weight is given in Grains: Or, divide the Weight by 76 times the ſpecific Gravity; the *Quotient* will be the Magnitude in cubic Feet, when the Weight is given in Pounds *Troy*.

FINIS.